STRUCTURE GEOTECHNICAL REPORT
CULVERT AT STA. 654+07.00
ILLINOIS 47 OVER KISHWAUKEE RIVER TRIBUTARY
EXISTING SN 056-0245; PROPOSED SN 056-0311
MCHENRY COUNTY, ILLINOIS

For
Strand Associates, Inc.
1170 South Houbolt Road
Joliet, IL 60432

Submitted by
Wang Engineering, Inc.
1145 North Main Street
Lombard, IL 60148

Original Report: August 24, 2018
Revised Report: N.A

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, Culvert at Sta. 654+07.00 Illinois Route 47 Over Kishwaukee River Tributary		**2. Original Date:** August 24, 2018 **Revised Date:** n.a **3. Report Type** ☒ SGR ☐ RGR ☐ Draft ☒ Final ☐ Revised
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6. PTB / Item No. 169/019	**7. Existing Structure Number(s)** 056-0245	**8. Proposed Structure Number(s)** 056-0311
9. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: Andri A. Kurnia, PE QA/QC: Corina T. Farez, PE, PG PM: Liviu Iordache, PG	**Contact** (630) 953-9928 ext. 1025 akurnia@wangeng.com
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11. Abstract

The existing 5-foot tall by 6-foot wide, concrete box culvert carrying Illinois 47 over Kishwaukee River Tributary will be removed and replaced with a longer, single cell cencrete box culvert. The new culvert will be 6-foot tall by 8-foot wide. The culvert's length will be 155 feet. New fill will be placed on top and around both culvert's ends. The culverts ends will be retained by aprons with wingwalls.

Beneath topsoil and pavement, the general lithologic profile encountered during the investigation includes about 4.5 feet of stiff to very stiff clay loam fill over stiff to hard clay to clay loam. The groundwater elevations range from 872 to 893 feet.

Design scour elevations are proposed to be at the bottom of the cutoff wall. We recommend removing the topsoil and cohesive soil with higher moisture content beneath the downstream end culvert base and replacing with granular aggregates beneath the downstream sections of the culvert. After the proposed removal, total long-term settlements are estimated to be 0.5 inches with a differential settlement of about 0.4 inches over 60 feet.

We recommend the wingwalls be designed for a maximum factored bearing resistance of 4,000 psf. Global stability analyses of the wingwalls show factors of safety meeting the minimum requirement of 1.5.

Wang estimates a temporary steel sheet piling according to IDOT Design Guide 3.13.1 is feasible and sufficient to accommodate stage construction.

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TABLE OF CONTENTS

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FOR
STRAND ASSOCIATES, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, geotechnical evaluations, and recommendations to support the removal and replacement of a culvert crossing Illinois Route 47 (IL 47) at Station 654+07.00 that is about 2000 feet north of the intersection between IL 176 West Leg and IL 47. The proposed structure is part of the widening and reconstruction of 1.65-mile-long of IL 47 between Station 565+80 and Station 653+00 in McHenry County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Based on the information provided by Strand Associates, Inc. (Strand) and Christopher B. Burke Engineering, Ltd. (CBBEL) on February 14, 2018 and the *Preliminary General Plan and Elevation* (GPE) received in May 2018, Wang Engineering, Inc. (Wang) understands the existing 5-foot tall by 6-foot wide culvert will be removed and replaced with a new and longer single cell concrete box culvert. The proposed culvert's cell will be 6-foot tall by 8-foot wide. The culvert's length will be 155 feet, about 112 feet longer than the existing one. The proposed culvert upstream invert elevation will be 903.7 feet and downstream invert elevation will be 903.6 feet; with flow directed from west to east. The proposed culvert barrel will have bottom elevation slightly lower than the existing. Aprons with cantilever type wingwalls are proposed to support the widened roadway embankment at both the upstream and downstream ends.

1.2 Existing Structure and Land Use

The existing 5-foot by 6-foot concrete box culvert was constructed in 1936 and has a total length of 43.0 feet. The culvert has an upstream invert elevation of 905.2 feet and a downstream invert elevation of 905.1 feet.

The purpose of this investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide recommendations for the design and construction of the proposed culvert replacement and wingwalls.

2.0 GEOLOGICAL SETTING

The project area is located along IL 47 about 2000 feet north of intersection of IL 176 West Leg and IL 47, in Dorr Townships, McHenry County, Illinois. On the USGS Huntley 7.5 Minute Series Quadrangle map, the project is located in SW ¼ of Section 28, Tier 44 N, Range 7 E of the Third Principal Meridian.

The following review of published geologic data, with emphasis on factors that might influence the design and construction of the proposed engineering works, is meant to place the project area within a geological framework and confirm the dependability and consistency of the subsurface investigation results. For the study of the regional geologic framework, Wang considered northeastern Illinois in general and McHenry County in particular. Exhibit 2 illustrates the *Site and Regional Geology.*

2.1 Physiography

The IL 47 at the culvert location runs through rural setting surrounded by agricultural used fields. The surface topography is generally flat with elevation of about 905 feet. IL 47 crosses over Kishwaukee River Tributary about 2000 feet north of the intersection of IL 176 West Leg and IL 47 with roadway of about 912 feet. The downstream invert elevation is about 903.6 feet and the water surface is at about 905.5 feet elevation.

2.2 Surficial Cover

The project area was shaped during the Wisconsin-age glaciation and about 200-foot thick overburden covers the bedrock. The glacigenic deposits were emplaced during pulsating advances and retreats of an icesheet lobe responsible for the formation of end moraines and associated low-relief till and lake plains (Hansel and Johnson 1996). The surficial cover within the project area consists of organic silt and clay of the Grayslake Peat found discontinuously throughout the project area. The Grayslake Peat overlies either the clay and silt of the Equality Formation, or the silty clayey diamicton of the Yorkville Member of the Lemont Formation. The clayey diamicton overlies the loamy diamicton of the Tiskilwa Formation or gravelly sand outwash of the Henry Formation. The outwash of the Henry Formation interfingers with the two diamictons.

The Grayslake Peat, less than 10 feet thick, consists of black to brown peat interbedded with gray organic reach sand, silt, and clay and white to light gray marl (Curry and Thomason 2012). The Equality Formation, less than 15 feet thick, consists of brown to gray bedded fine sand, silt, and clay lacustrine deposits (Curry and Thomason 2012). The Henry Formation consists of stratified sand and gravel outwash with thicknesses of about 5 to 10 feet, within the project limits (Curry and Thomason 2012). The Yorkville Member of the Lemont Formation, up to 30 feet thick, consists of yellowish brown to gray silty clay to silty clay loam diamicton that contains lenses of gravel, sand, silt, and clay (Hansel and Johnson 1996, Curry and Thomason 2012). The Tiskilwa Formation, about 55 feet thick, consists of calcareous reddish brown to gray clay loam, loam to sandy loam diamicton that contains lenses of gravel, sand, silt, and clay (Wickham et al. 1988, Curry and Thomason 2012). The Tiskilwa Formation diamicton rests over the Illinoian-age drift, which in turn unconformably rests over the Silurian-age dolostone (Curry and Thomason 2012). The diamicton account for about 75% of the subsurface soil.

From a geotechnical viewpoint, the Yorkville Member characterized by low plasticity to moderate, high strength, and low to moderate moisture content and the Tiskilwa Formation characterized by low plasticity, medium to high strength, low moisture content, moderately to highly pebbly (Bauer et al. 1991).

2.3 Bedrock

In McHenry County, the surficial cover rests unconformably on top of Silurian-age and Ordovician-age bedrock. The top of the bedrock lies about 160 to 200 feet below the ground surface (bgs). Structurally, the site is located on the eastern flank of the Wisconsin Arch (Willman 1971). No active faults or underground mines are known in the area

Our subsurface investigation results fit into the local geologic context. None of the borings were deep enough to encounter either the loamy diamicton of the Tiskilwa Formation or bedrock.

3.0 METHODS OF INVESTIGATION

The following sections outline the subsurface and laboratory investigations performed by Wang.

3.1 Field Investigation

The subsurface investigation consisted of three soil borings, designated as CUL-07 to CUL-09, drilled by Wang in October and November of 2017. Two borings were drilled outside of the roadway within

the new culvert limits from elevations of 904.7 to 906.2 feet and one boring was drilled from the roadway pavement at elevation of 911.7 feet. The borings were advanced to depths of 35 to 45 feet bgs. The as-drilled northing and easting coordinates were acquired with a mapping-grade GPS unit; boring elevations were surveyed with a level. Stations and offsets were determined from drawings provided by Strand. Boring location data are presented in the *Boring Logs* (Appendix A) and the as-drilled boring locations are shown in the *Boring Location Plan* (Exhibit 3).

An ATV-mounted drilling rig, equipped with hollow stem augers, was used to advance and maintain open boreholes. Soil sampling was performed according to AASHTO T206, *"Penetration Test and Split Barrel Sampling of Soils."* The soil was sampled at 2.5-foot intervals to 30 feet bgs and at 5.0-foot intervals thereafter. Soil samples collected from each sampling interval were placed in sealed jars and transported to the laboratory for further examination and laboratory testing.

Field boring logs, prepared and maintained by a Wang geologist, include lithological descriptions, visual-manual soil (IDH Textural) classifications, results of Rimac and pocket penetrometer unconfined compressive strength tests, and results of Standard Penetration Tests (SPT) recorded as blows per 6 inches of penetration.

Groundwater levels were measured while drilling and at completion of each boring. Each borehole was backfilled upon completion with soil cuttings and/or bentonite chips.

3.2 Laboratory Testing

The soil samples were tested in the laboratory for moisture content (AASHTO T265). Atterberg limits (AASHTO T89 and T90) and particle size (AASHTO T88) analyses were performed on selected samples. Field visual descriptions of the soil samples were verified in the laboratory. Laboratory test results are shown in the *Boring Logs* (Appendix A) and in the *Laboratory Test Results* (Appendix B).

4.0 INVESTIGATION RESULTS

Detailed descriptions of the soil conditions encountered during the subsurface investigation are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profile* (Exhibit 4). Please note that strata contact lines represent approximate boundaries between soil types. The actual transition between soil types in the field may be gradual in horizontal and vertical directions.

4.1 Lithological Profile

At the surface, the borings encountered 14- to 21-inch thick black silty clay loam topsoil or 9-inch thick asphalt over 10-inch thick concrete pavement. In descending order, the general lithologic succession encountered beneath the surface includes: 1) man-made ground (fill); 2) stiff to hard clay to clay loam.

1) Man-made ground (fill)

Fill was encountered in Boring CUL-07, which was drilled through the IL 47 roadway pavement. Beneath the surface, the boring encountered up to 4.5 feet of stiff to very stiff, brown clay loam fill. The fill has unconfined compressive strength (Q_u) values of 1.9 and 3.5 tsf and moisture content values of 11 and 17%. Beneath the fill, about 36 inches of stiff, black clay loam buried topsoil was encountered.

2) Stiff to Hard Clay to Clay Loam

At elevations of 903.0 to 905.0 feet, the borings advanced through stiff to hard, brown and gray clay to clay loam with lenses of gravel and sand. The cohesive soil has Q_u values of 1.0 to 6.1 tsf with an average of 2.2 tsf and moisture content values of 9 to 28% with an average of 13%. The borings were terminated within this unit. Laboratory index testing shows liquid limit (L_L) values of 22 to 48% and plastic limit (P_L) values of 12 to 24%. The higher L_L and P_L (L_L 48% and P_L 20%) was observed in the first 5 feet of Boring CUL-09.

4.2 Groundwater Conditions

While drilling, groundwater was encountered in the interbedded granular lenses within the cohesive soils at elevation of 871.8 and 892.5 feet (12.8 and 39.9 feet bgs). At the completion of drilling, groundwater was measured at elevations of 872.3 and 877.5 feet (32.4 and 34.3 feet bgs).

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the culvert and aprons with cantilever wingwalls are included in the following sections. The proposed culvert replacement will have upstream and downstream invert elevations of 903.7 and 903.6 feet, respectively and the base of the culvert barrel will be installed slightly deeper than the existing. Aprons with vertically cantilevered wingwall types will be used to support the roadway embankment widening at both ends.

Wang has performed bearing capacity, settlement, and global stability analyses for the proposed culvert barrel and wingwalls.

5.1 Scour Considerations

The design scour elevation should be taken at the bottom of the cutoff wall (IDOT 2012). For horizontal cantilever wingwalls, the cutoff walls are established 3.0 feet below the culvert invert elevations; whereas for T-type wingwalls, the cutoff walls are established 4.0 feet below the invert elevations. The design scour elevations with cutoff walls established at 4.0 feet below the invert elevations, as shown in the GPE drawing, are summarized in Table 1. To prevent local erosion, we recommend placing stone riprap or a concrete apron at the ends of the culvert; this will be particularly important if precast sections are used. This will also prevent sediments from entering and accumulating in the culvert, minimize long-term maintenance, and provide protection to the streambed at the interface.

Table 1: Design Scour Elevations

	Upstream	Downstream
Design Scour Elevations (feet)	899.7	899.6

5.2 Ground Treatment

The subsurface investigation indicates the soils at the downstream (east end) of the culvert base are primarily topsoil followed by stiff clay to silty clay with higher moisture of 28%. To increase bearing capacity, mitigate settlement issues, and to provide stable working platforms, Wang recommends removal and replacement of topsoil and higher moisture soil at the downstream section. The recommended removal limits and depths are:

- from the downstream end of the culvert going 60 feet upstream, for a depth of 2.5 feet below the proposed bottom of the culvert or to elevation 900.0 feet.

A sketch the proposed removal is shown in Exhibit 5The replacement material should extend a minimum of two feet beyond each side of the box (IDOT 2016). In addition, the following note should be shown in the plans.

"The limits and quantities of removal and replacement shown are based on the boring data and may be modified by the District Geotechnical and Field Engineers for variable subsurface conditions encountered in the field."

5.3 Bearing Capacity

After the proposed removal and replacement, the barrel and apron with wingwalls should be designed based on a maximum factored soil bearing resistance of 4,000 psf. The factored soil bearing resistance was determined using bearing resistance factor (ϕ_b) of 0.45 (AASHTO 2016). The wingwalls should be sized and designed based on the information and typical sections shown in IDOT *Culvert Manual*, Sections 4.3 and 4.4. (IDOT 2017).

Culvert wingwalls could be constructed as horizontal cantilever walls if they will be less than 16 feet in length and the wingwall location can be adequately dewatered (IDOT 2017). Horizontal cantilever walls should be designed based on the structural guidelines provided in Section 4.2 of the IDOT (2017). These wingwalls should be founded at a minimum depth of 3.0 feet below the culvert invert elevations.

According to IDOT (2017), the soil lateral pressure acting on the sidewalls of the box culvert should be assumed as an equivalent fluid pressure of 60 pcf. Earth surcharge should be added in non-zero fill conditions and live load surcharge shall be applied to all culverts regardless of fill height as discussed in IDOT (2017) Section 3.4.5.

The wingwalls types suitable for precast concrete culvert include apron, driven sheet pile and cast-in-place T-type wingwalls. For the cast-in-place culvert, the horizontal cantilever, L-type or T-type wingwalls are typically considered. The apron wingwalls should be designed and constructed based on IDOT Specifications and IDOT Base Sheet dated 2/17/2017 " *SCB-GPE*."

5.4 Settlement

As discussed in Section 5.2, topsoil and cohesive soil with high moisture will be encountered below the base of the proposed culvert. We estimate up to 1 inches of settlement under the new culvert and fill loads.After the proposed removal and replacement, we estimate the foundation soils will experience total long-term settlements of about 0.5 inches, with differential settlements of 0.4 inch over 60 feet. We estimate the settlements are suitable for the construction of the proposed culvert, aprons, and wingwalls.

5.5 Global Stability

The global stability of the fill material to be placed behind the wingwalls was analyzed based on the generalized soil profile described in Section 4.1. The maximum total fill height behind the wingwalls will be about 6 feet with a backfill slope of 1:3 (V:H). We performed global stability analyses for the

wingwalls at the east end section. Global stability was analyzed for both undrained (short-term) and drained (long-term) conditions. The analyses were performed with *Slide v6.0* and the results of the evaluations are provided in Appendix C. We estimate a factor of safety (FOS) of 4.9 for undrained soil condition and a FOS of 2.6 for drained soil condition. The FOSs meet the minimum FOS requirement of 1.5 (IDOT 2015).

5.6 Cast-In-Place or Precast Culvert Considerations

After the recommended removal of unsuitable soil, the results of the analyses indicate that both the cast-in-place and precast culvert options are appropriate and feasible at the site. The differential settlement will be about 0.4 inch over 60 feet, which will not cause excessive separation of the precast sections. For precast end sections, we recommend considering either a concrete apron or riprap armoring at the downstream invert to protect against scour and erosion that could undermine the precast end section assuming a hydraulic analysis does not indicate a low-scour condition.

5.7 Stage Construction Considerations

The preliminary GPE shows stage construction lines for the culvert construction. Wang understands a temporary sheet piling system may be utilized to accommodate stage construction. The sheet piling should be designed based on IDOT Design Guide 3.13.1. Assuming an exposed height of about 10.5 feet (from elevation 912.1 feet to 901.7 feet) located at the center line, our evaluations indicate the temporary steel sheet piling is feasible and sufficient.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

The existing culvert be removed and any vegetation, surface topsoil, and debris should be cleared and stripped where the proposed culvert and wingwalls will be placed. If unstable or unsuitable materials are exposed during excavation, they should be removed and replaced with compacted structural fill as described in Section 6.3. The embankment fill behind the proposed wall will be placed against existing sloped embankment. These existing embankments should be deeply plowed or benched in accordance with IDOT Section 205.03 (IDOT 2016) prior to the placement of fill materials.

6.2 Excavation, Dewatering, and Utilities

Excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction. Excavations for the placement of the culvert barrel should be steeped at no steeper than 1:2 (V:H).

Any slopes that cannot be graded at 1:2 (V: H) should be properly shored with temporary sheeting or soil retention systems. Excavated material should not be stockpiled immediately adjacent to the top of slopes, nor should equipment be allowed to operate too closely to open excavations.

Any water that accumulates in open excavations by seepage or runoff should be immediately removed by sump-pump. Depending upon prevailing climate conditions and the time of the year when culvert construction takes place, control runoff and maintenance of existing flows may require temporary water diversion and control. Contractor should be prepared for dewatering measures should groundwater be encountered above the proposed excavation depth.

6.3 Filling and Backfilling

Fill material used to attain the final design elevations should be structural fill material. Coarse aggregate of IDOT gradation CA-6 or pre-approved, compacted, cohesive or granular soil conforming to Section 204 would be acceptable as structural fill (IDOT, 2016). The fill material should be free of organic matter and debris and should be placed in lifts and compacted according to IDOT Section 205, *Embankment* (IDOT, 2016).

Groundwater may exist beneath the culvert. As mentioned in IDOT (2017), in cases such as replacement below box culvert where dewatering and compaction may not be possible, the pay item "Rockfill" is commonly used. In this case, the following note should be added.

"The Rockfill shall be capped with 6 in. of CA7 and satisfy the Standard Specifications unless otherwise indicated in the Special Provisions. The cost of the capping material shall be included in the pay item for Rockfill."

6.4 Earthwork Operations

The required earthwork can be accomplished with conventional construction equipment. Moisture and traffic will cause deterioration of exposed subgrade soils. Precautions should be taken by the Contractor to prevent water erosion of the exposed subgrade. A compacted subgrade will minimize water runoff erosion.

Earth moving operations should be scheduled to not coincide with excessive cold or wet weather (early spring, late fall or winter). Any soil allowed to freeze or soften due to the standing water should be removed. Wet weather can cause problems with subgrade compaction.
It is recommended that an experienced geotechnical engineer be retained to inspect the exposed

subgrade, monitor earthwork operations, and provide material inspection services during the construction phase of this project.

7.0 QUALIFICATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on the boring logs and in Exhibit 3. This report does not reflect any variations that may occur between the borings or elsewhere on the site, variations whose nature and extent may not become evident until the course of construction. In the event that any changes in the design and/or location of the structure are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

It has been a pleasure to assist Strand Associates, Inc. and the Illinois Department of Transportation on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Andri A. Kurnia, P.E.
Senior Geotechnical Engineer

Corina T. Farez, P.E., P.G.
QA/QC Reviewer

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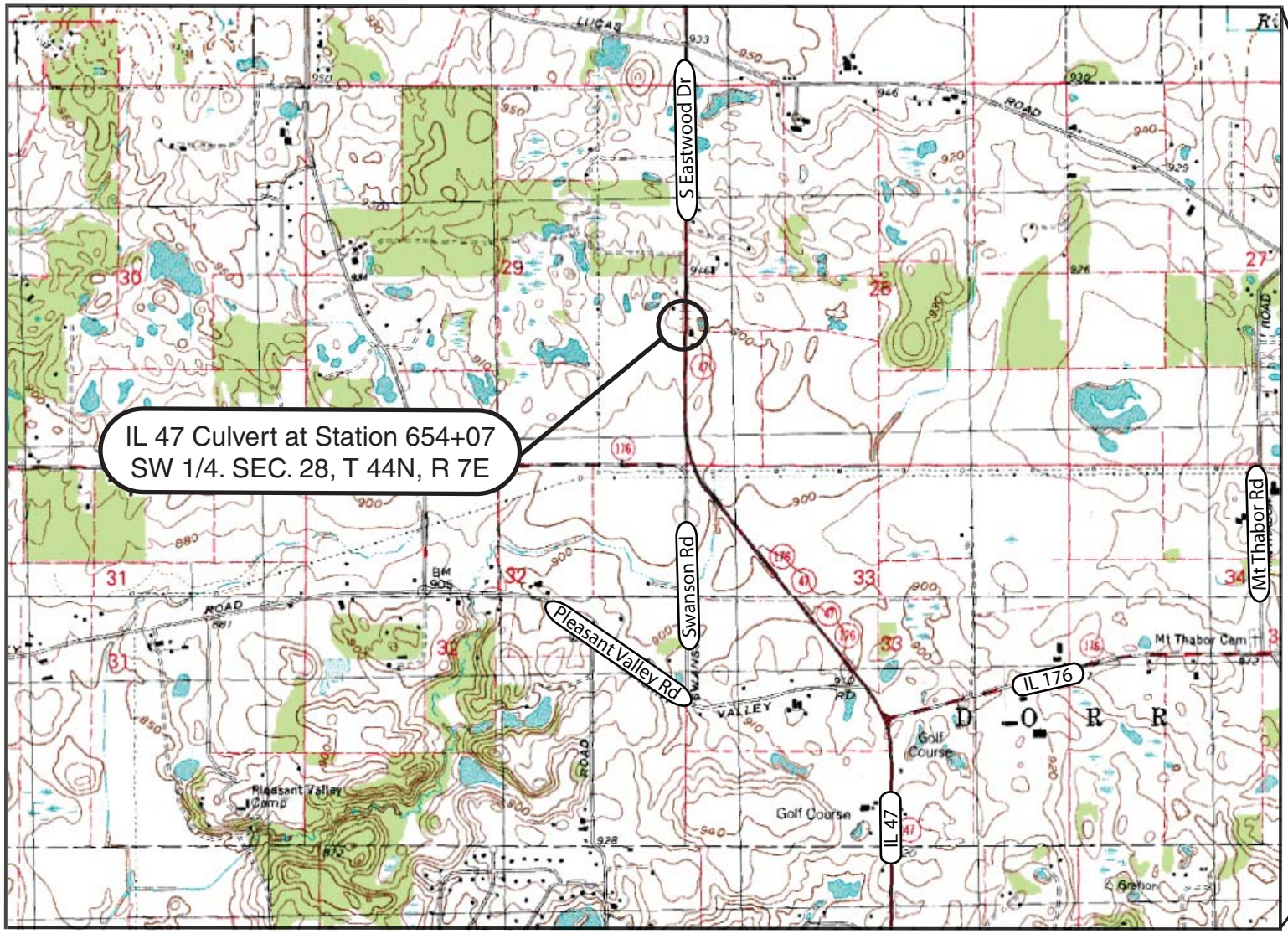
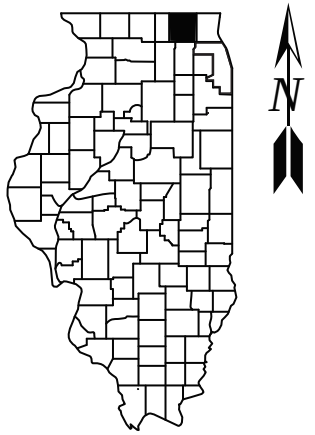
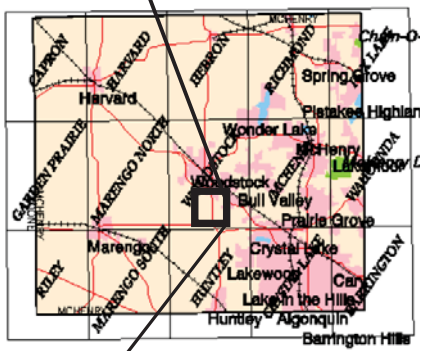
EXHIBITS







McHenry County

Scale

0 1 2 Mile

SITE LOCATION MAP: IL 47 CULVERT AT STATION 654+07, SN 056-0311, MCHENRY COUNTY

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: RKC CHECKED BY: A. Kurnia

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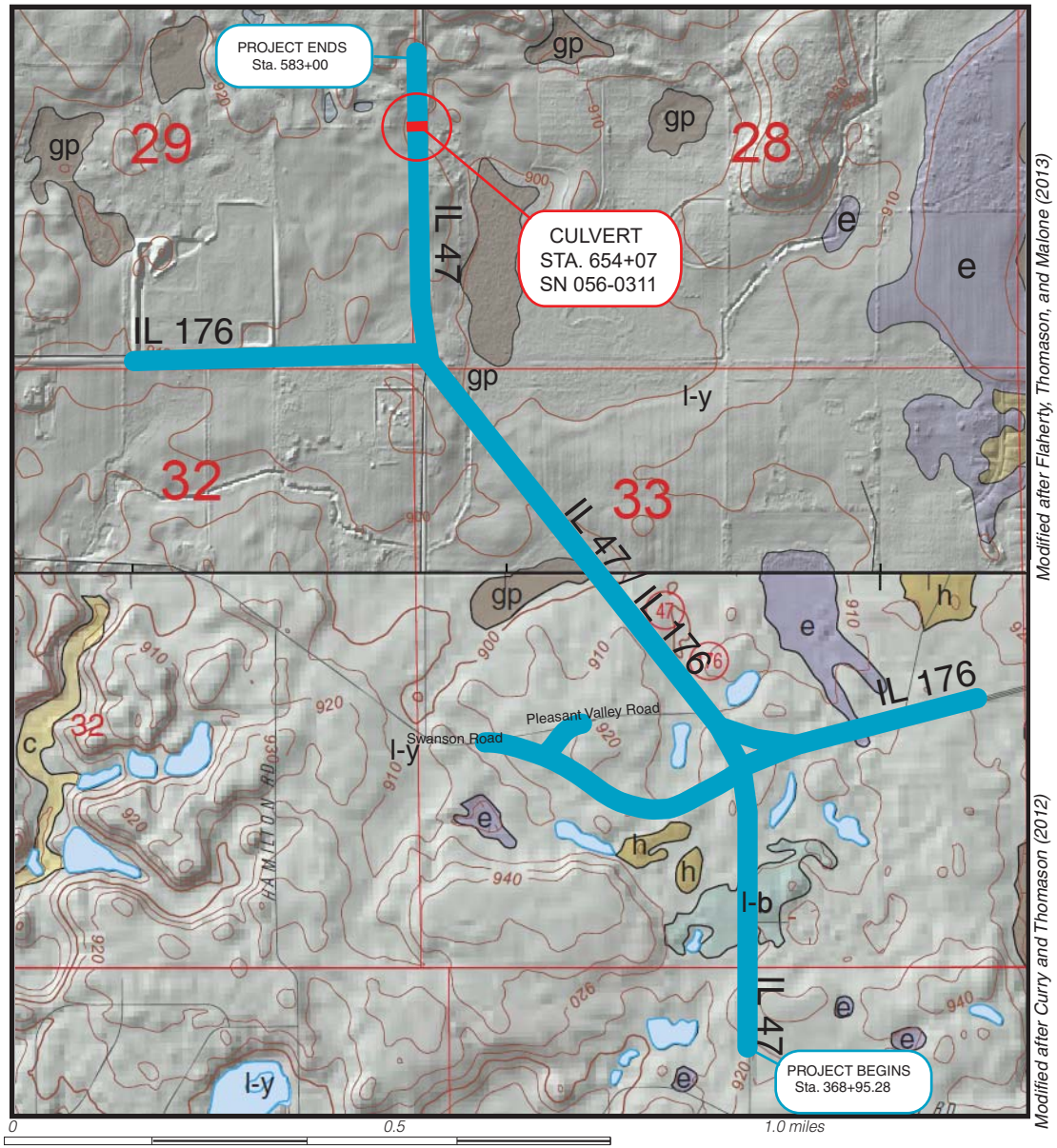
FOR STRAND ASSOCIATES, INC. 195-13-01



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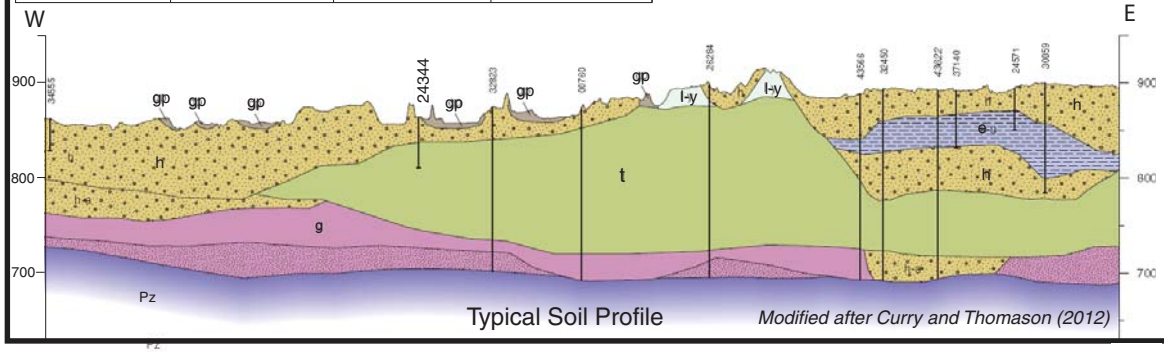
Modified after Curry and Thomason (2012)



Typical Soil Profile

Modified after Curry and Thomason (2012)

REGIONAL GEOLOGY

Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

Modified after Hansel and Johnson (1996)

LEGEND

HUDSON EPISODE

gp — **Grayslake Peat**
Decomposed wetland vegetation and sediment; peat and muck, interbedded sand, silty clay, and marl

WISCONSIN EPISODE

e — **Equality Formation**
Lake deposits in kettles and valleys; silt, clay, and fine sand; layered to massive

h — **Henry Formation**
Proglacial outwash plains downslope of glacial margins; sand and gravel, or sand; with lenses of silt and clay, or diamicton

l-y — **Lemont Fornation, Yorkville Member**
Debris flow deposits and diamicton; silty clay, silty clay loam, and clay, includes layers of sand and gravel

l-b — **Lemont Formation, Batestown Member (Cross section only)**
Debris flow deposits and diamicton; sandy loam to loam with abundant cobbles; includes layers of sand and gravel or silt and sorted sediment

t — **Tiskilwa Formation (Cross section only)**
Till, debris flow deposits, and outwash; clay loam to loam; includes lenses of sand and gravel.

ILLINOIS EPISODE

g — **Glasford Formation (Cross section only)**
Till and debris flow deposits (diamicton) and outwash (sand and gravel); the diamicton is bouldery in places with reddish brown, sandy loam to loam matrix, with abundant lenses, and channel fills of sand and gravel.

PALEOZOIC BEDROCK

Pz — **Bedrock (Cross section only)**
Dolomite, shaly dolomite, and shale

Modified after Curry and Thomason (2012)

SITE AND REGIONAL GEOLOGY: CULVERT AT STATION 654+07
SN 056-0311, MCHENRY COUNTY

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. Marin CHECKED BY: L. Iordache

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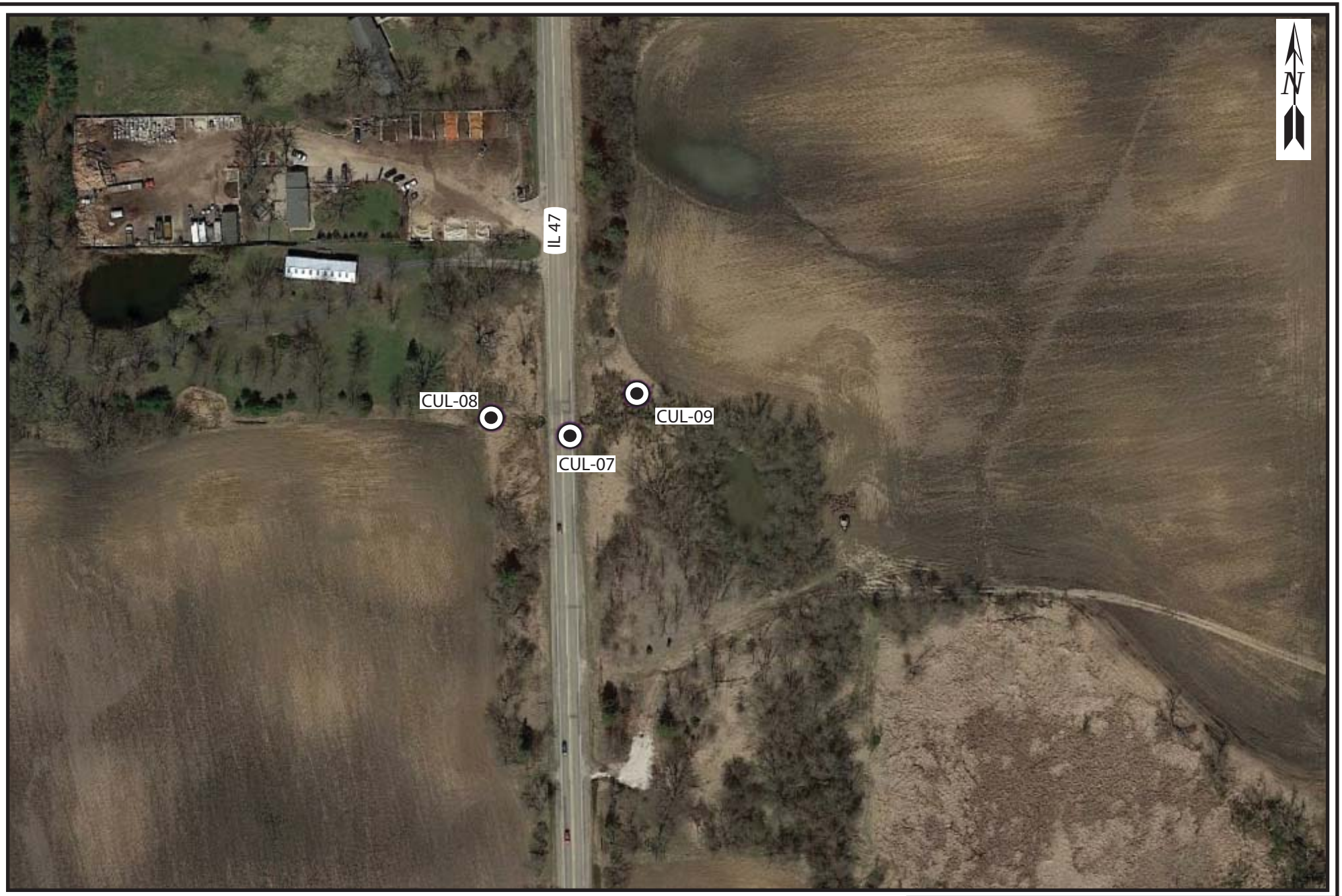
FOR STRAND ASSOCIATES, INC.

195-13-01



Legend

◉ Culvert Borings

Scale

0 250 500 Feet

BORING LOCATION PLAN: IL 47 CULVERT AT STATION 654+07, SN 056-0311, MCHENRY COUNTY

SCALE: GRAPHICAL	EXHIBIT 3	DRAWN BY: RKC CHECKED BY: A. Kurnia

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FOR STRAND ASSOCIATES, INC. 195-13-01

W

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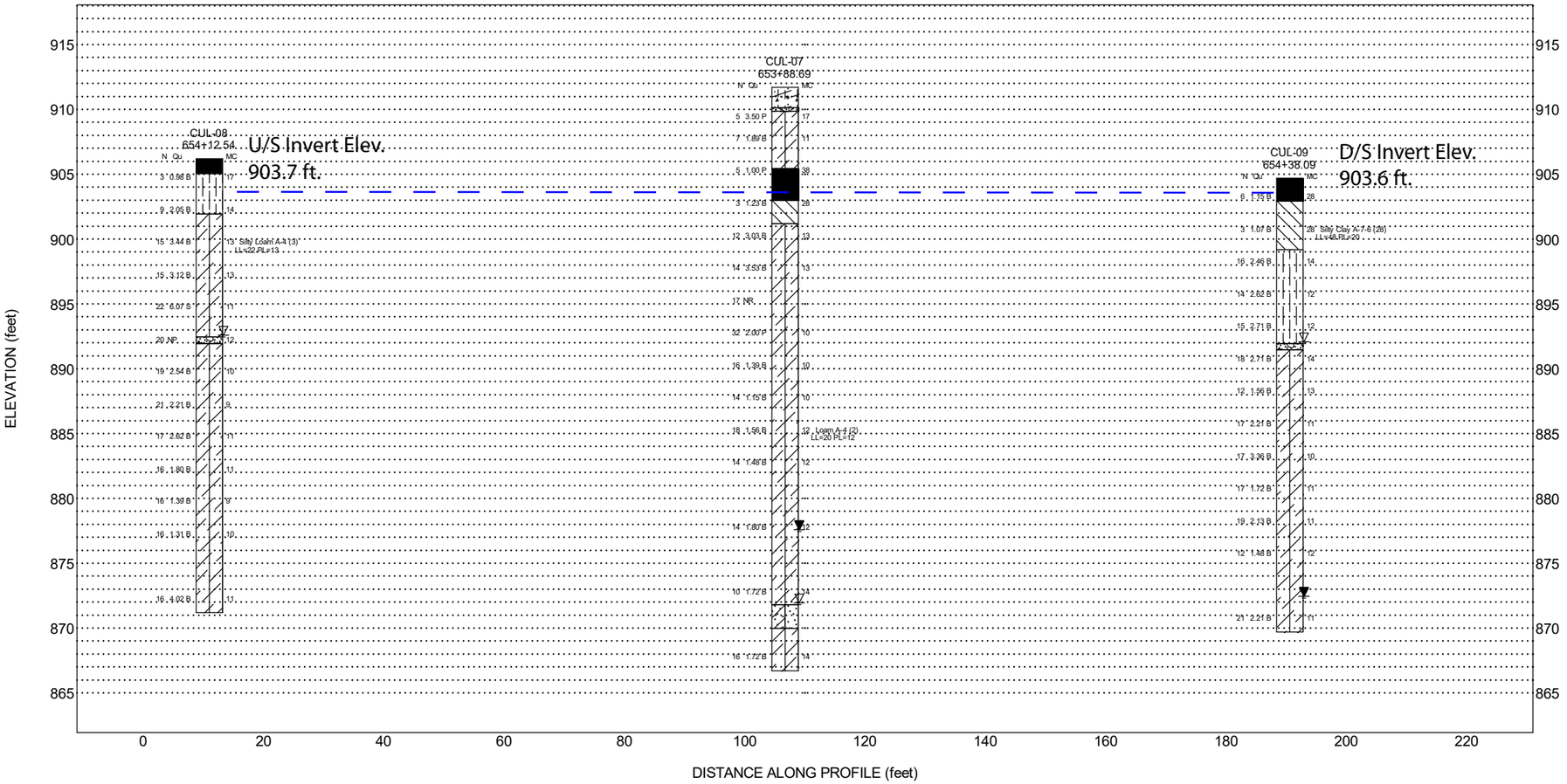
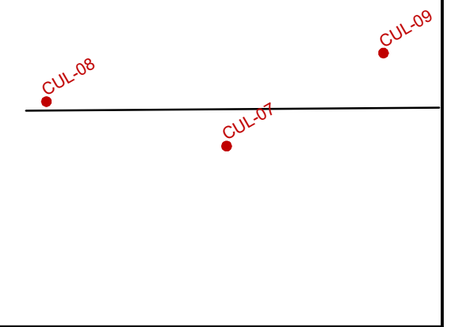


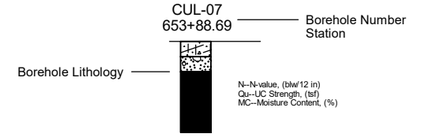
Lithology Graphics

- Pavement
- Gravelly sand, sandy gravel
- IDH Clay Loam
- Topsoil
- IDH Clay
- IDH Loam
- IDH Silty Clay, Silty Clay Loam



Site Map Scale 1 inch equals 80 feet

Explanation:



- Water Level Reading at time of drilling.
- Water Level Reading 24-hr after drilling or at end of drilling

Horizontal Scale (feet)

Vertical Exaggeration: 2x

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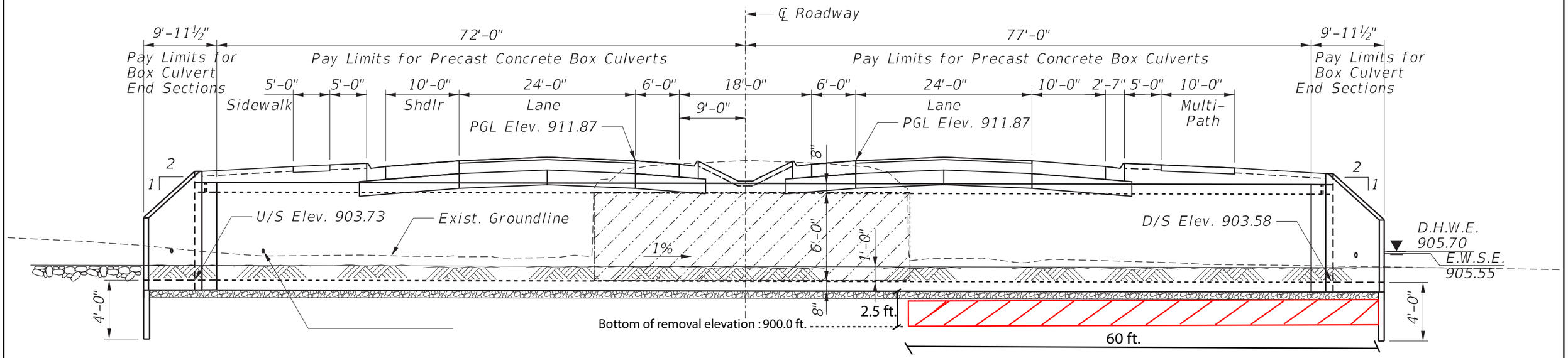
Soil Profile
Culvert at Sta. 654+07, SN 056-0311

WEI SINCE 1982

IL 47 between US 14 and S of IL 176
McHenry County, Illinois

JOB NUMBER	PLATE NUMBER
195-13-01	EXHIBIT 4



REMOVAL AND REPLACEMENT SKETCH:IL 47 CULVERT AT STATION 654+07, SN 056-0311, MCHENRY COUNTY

SCALE: GRAPHICAL	EXHIBIT 5	DRAWN BY: RKC CHECKED BY: A. Kurnia

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APPENDIX A

Wang Engineering

LEGEND FOR BORING LOG

Relative Density of Non-Cohesive Soils	
N-Blows/ 12 inches	**Relative Density Term**
0-3	Very Loose
4-9	Loose
10-29	Medium Dense
30-49	Dense
50-80+	Very Dense

Consistency of Cohesive Soils	
Unconfined Compressive Strength Qu, tsf	**Consistency Term**
<0.25	Very Soft
0.25-0.49	Soft
0.50-0.99	Medium Stiff
1.00-1.99	Stiff
2.00-3.99	Very Stiff
>4.00	Hard

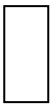
Relative Drilling Resistace	
RDR	**Drilling Resistance Term**
1	Very Easy
2	Easy
3	Moderate
4	Hard
5	Very Hard

Proportional Terms		
Trace	1-9	Percent of Dry Weight
Little	10-19	
Some	20-34	
And	35-50	

Gradation Terminology	
Boulders	>200mm
Cobbles	200mm to 75mm
Gravel	75mm to 2mm
Sand	2-0mm to 0.074mm
Silt	0.074mm to 0.002mm
Clay	<0.002mm

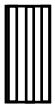
Sample Type Symbols

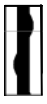

Split Spoon


No Recovery


Geoprobe


Rock Core


Shelby Tube


Auger Cuttings

SS = Split Spoon

ST = Shelby Tube

SPT = Standard Penetration Test

Q_u = Unconfined Compressive Strength

P = Pocket Penetrometer

S = Shear failure of sample, Rimac test

B = Bulge failure of sample, Rimac test

SSA = Solid Stem Augers,

HSA = Hollow Stem Augers,

Drill Rig:

TMR = Truck Mouted Rig

ATV = All Terrain Vehicle Rig

[--%] = SPT Hammer Efficiency


In-situ Vane Shear Test

SPT = Standard Penetration Test

N Value is the sum of the second and the third numbers

04/28/2017

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BORING LOG CUL-07

WEI Job No.: 195-13-01

Client: **Strand Associates, Inc.**
Project: **IL 47 between US 14 and S of IL 176**
Location: **McHenry County, Illinois**

Datum: NGVD
Elevation: 911.70 ft
North: 2037591.35 ft
East: 957259.53 ft
Station: 653+88.69
Offset: 7.5 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		9-inch thick, ASPHALT over 10-inch thick, CONCRETE --PAVEMENT--						
	910.1							
	909.9	3-inch thick, BASE COURSE						
		Stiff to very stiff, brown CLAY LOAM, trace gravel; damp --RDR 2-- --FILL--			1	4 2 3	3.50 P	17
					2	2 3 4	1.89 B	11
			5					
	905.5	Stiff, black CLAY; damp --BURIED TOPSOIL-- --RDR 2--			3	3 2 3	1.00 P	38
	903.0	Stiff, brown and gray CLAY to SILTY CLAY; damp --RDR 1--	10		4	2 1 2	1.23 B	28
	901.2	Stiff to very stiff, pinkish brown CLAY LOAM to LOAM, trace to some gravel; damp --RDR 2--			5	4 6 6	3.03 B	13
			15		6	3 7 7	3.53 B	13
					7	7 7 10	NR	
			20		8	8 19 13	2.00 P	10
			25		9	7 7 9	1.39 B	10
					10	6 7 7	1.15 B	10
		--L_L(%)=20, P_L(%)=12-- --%Gravel=8.8-- --%Sand=32.2-- --%Silt=45.4-- --%Clay=13.7-- --A-4 (2)--			11	6 7 11	1.56 B	12
			30		12	3 6 8	1.48 B	12
	871.8		35		13	5 6 8	1.80 B	12
			40		14	3 4 6	1.72 B	14

GENERAL NOTES

Begin Drilling: **10-27-2017** Complete Drilling: **10-27-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **D50 ATV [88%]**
Driller: **R&K** Logger: **T. Rothschild** Checked by: **C. Marin**
Drilling Method: **2.25 IDA HSA; 140 lb autohammer; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **39.90 ft**
At Completion of Drilling: **34.25 ft**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG CUL-07

WEI Job No.: 195-13-01

Client **Strand Associates, Inc.**
Project **IL 47 between US 14 and S of IL 176**
Location **McHenry County, Illinois**

Datum: NGVD
Elevation: 911.70 ft
North: 2037591.35 ft
East: 957259.53 ft
Station: 653+88.69
Offset: 7.5 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		Gray LOAM; damp						
	870.0							
		Stiff, pinkish brown CLAY LOAM, trace gravel; damp --RDR 2--						
					15	6 7 9	1.72 B	14
	866.7		45					
		Boring terminated at 45.00 ft						
			50					
			55					
			60					

GENERAL NOTES

Begin Drilling **10-27-2017** Complete Drilling **10-27-2017**
Drilling Contractor **Wang Testing Services** Drill Rig **D50 ATV [88%]**
Driller **R&K** Logger **T. Rothschild** Checked by **C. Marin**
Drilling Method **2.25 IDA HSA; 140 lb autohammer; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **39.90 ft**
At Completion of Drilling ▼ **34.25 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG CUL-08

WEI Job No.: 195-13-01

Client: **Strand Associates, Inc.**
Project: **IL 47 between US 14 and S of IL 176**
Location: **McHenry County, Illinois**

Datum: NGVD
Elevation: 906.20 ft
North: 2037615.04 ft
East: 957163.64 ft
Station: 654+12.54
Offset: 88.35 LT

Elevation (ft)	Depth (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
905.0		14-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
		Medium stiff to very stiff, brown and gray SILTY CLAY to SILTY CLAY LOAM, trace gravel; damp --RDR 2--		1	2 2 1	0.98 B	17
902.0		Very stiff to hard, brown CLAY LOAM to SILTY LOAM, trace gravel; damp --RDR 2--		2	2 4 5	2.05 B	14
	5	--L_L(%)=22, P_L(%)=13-- --%Gravel=3.7-- --%Sand=25.1-- --%Silt=53.5-- --%Clay=17.7-- --A-4 (3)--		3	5 7 8	3.44 B	13
	10			4	6 6 9	3.12 B	13
				5	4 10 12	6.07 S	11
892.5			▽				
892.0		GRAVELLY SAND; saturated		6	7 12 8	NP	12
	15	Stiff to hard, gray CLAY LOAM, trace to little gravel; damp --RDR 2--		7	6 8 11	2.54 B	10
	20			8	7 9 12	2.21 B	9
	25				4 7 10	2.62 B	11
					6 7 9	1.80 B	11
	30				10 7 9	1.39 B	9
					5 6 10	1.31 B	10
871.2	35	Boring terminated at 35.00 ft			4 7 9	4.02 B	11
	40						

GENERAL NOTES

Begin Drilling: **11-21-2017** Complete Drilling: **11-21-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **D50 ATV [88%]**
Driller: **K&K** Logger: **T. Rothschild** Checked by: **C. Marin**
Drilling Method: **2.25 IDA HSA; 140 lb autohammer; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **13.75 ft**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG CUL-09

WEI Job No.: 195-13-01

Client: **Strand Associates, Inc.**
Project: **IL 47 between US 14 and S of IL 176**
Location: **McHenry County, Illinois**

Datum: NGVD
Elevation: 904.70 ft
North: 2037640.87 ft
East: 957343.06 ft
Station: 654+38.09
Offset: 91.1 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		21-inch thick, black SILTY CLAY LOAM, trace organic --TOPSOIL--						
	903.0	Stiff, gray CLAY to SILTY CLAY; damp --RDR 2--			1	0 2 4	1.15 B	28
		--L_L(%)=48, P_L(%)=20-- --%Gravel=0.1-- --%Sand=6.9-- --%Silt=51.8-- --%Clay=41.2-- --A-7-6 (28)--	5		2	2 2 1	1.07 B	28
	899.2	Very stiff, brown and gray SILTY CLAY LOAM to CLAY LOAM, trace gavel; damp --RDR 2--			3	4 8 8	2.46 B	14
			10		4	4 6 8	2.62 B	12
					5	5 6 9	2.71 B	12
	892.0							
	891.5	GRANULAR; saturated						
		Stiff to very stiff, gray CLAY LOAM, trace gravel; damp --RDR 2--	15		6	4 7 11	2.71 B	14
					7	8 9 3	1.56 B	13
			20		8	5 6 11	2.21 B	11
			25			5 7 10	3.36 B	10
						5 7 10	1.72 B	11
						5 6 13	2.13 B	11
			30			5 4 8	1.48 B	12
						5 9 12	2.21 B	11
	869.7	Boring terminated at 35.00 ft	35					
			40					

GENERAL NOTES

Begin Drilling: **11-21-2017** Complete Drilling: **11-21-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **D50 ATV [88%]**
Driller: **K&K** Logger: **T. Rothschild** Checked by: **C. Marin**
Drilling Method: **2.25 IDA HSA; 140 lb autohammer; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **12.75 ft**
At Completion of Drilling: **32.40 ft**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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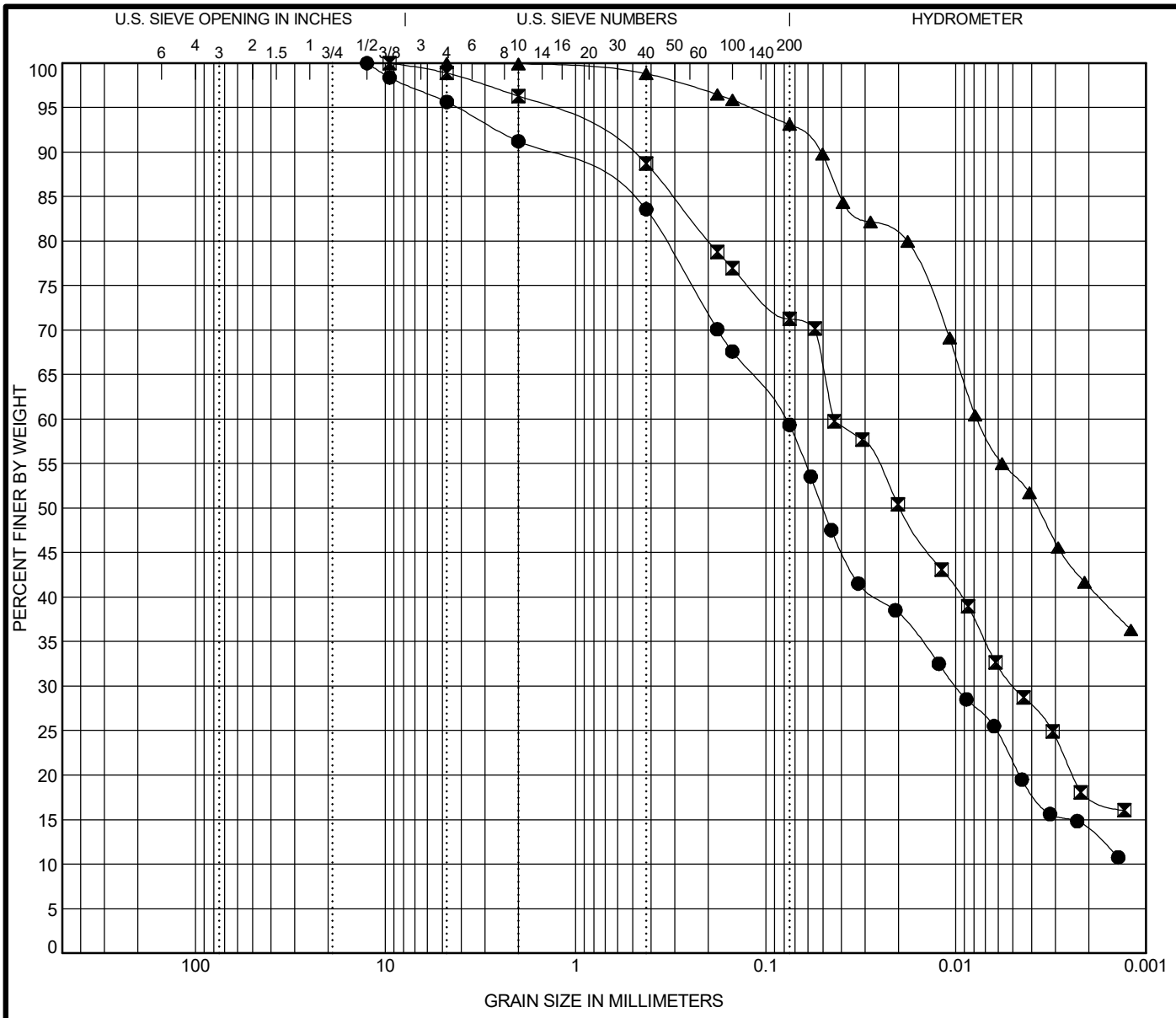
APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	CUL-07#11	26.0 ft	Loam	20	12	8		
⊠	CUL-08#3	6.0 ft	Silty Loam	22	13	9		
▲	CUL-09#2	3.5 ft	Silty Clay	48	20	28		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	CUL-07#11	26.0 ft	12.5	0.079	0.01		8.8	32.2	45.4	13.7
⊠	CUL-08#3	6.0 ft	9.5	0.044	0.005		3.7	25.1	53.5	17.7
▲	CUL-09#2	3.5 ft	4.75	0.008			0.1	6.9	51.8	41.2

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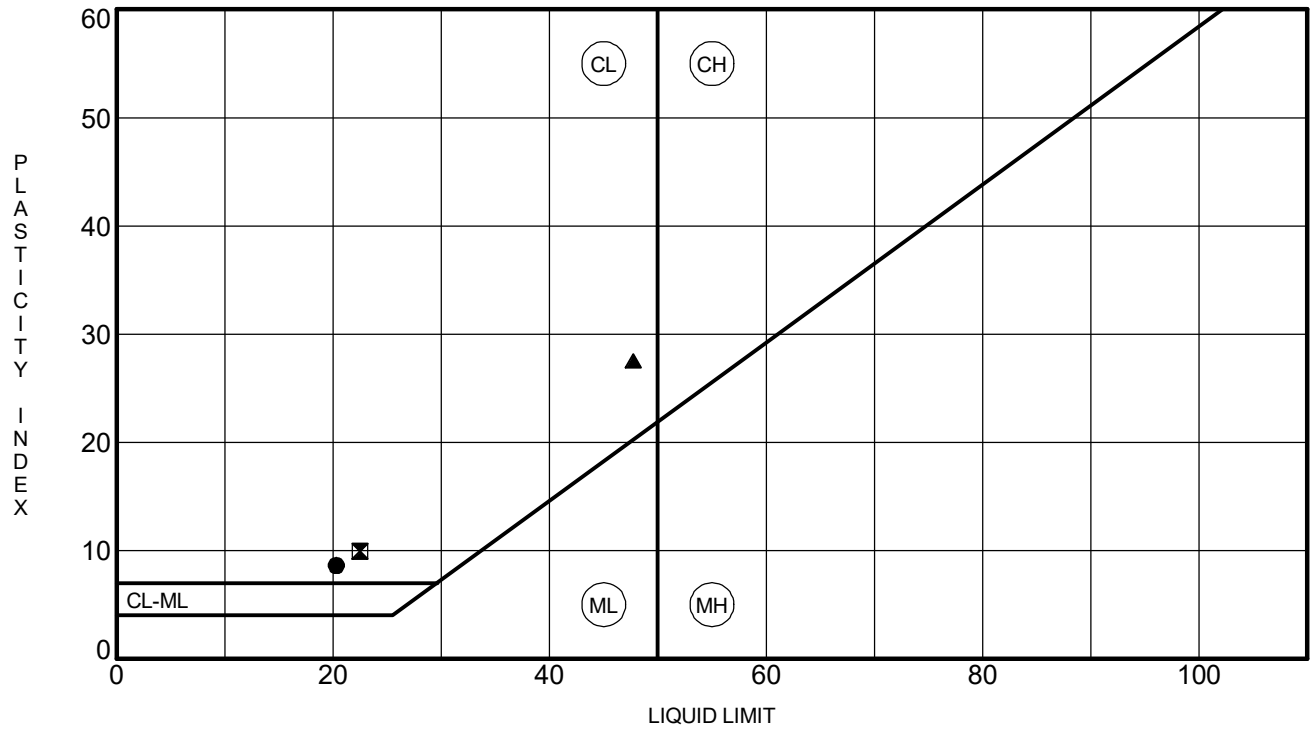
GRAIN SIZE DISTRIBUTION

Project: IL 47 between US 14 and S of IL 176

Location: McHenry County, Illinois

Number: 195-13-01



Specimen Identification			LL	PL	PI	Fines	IDH Classification
●	CUL-07#11	26.0 ft	20	12	8	59	**Loam**
⊠	CUL-08#3	6.0 ft	22	13	9	71	**Silty Loam**
▲	CUL-09#2	3.5 ft	48	20	28	93	**Silty Clay**

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ATTERBERG LIMITS' RESULTS

Project: IL 47 between US 14 and S of IL 176

Location: McHenry County, Illinois

Number: 195-13-01

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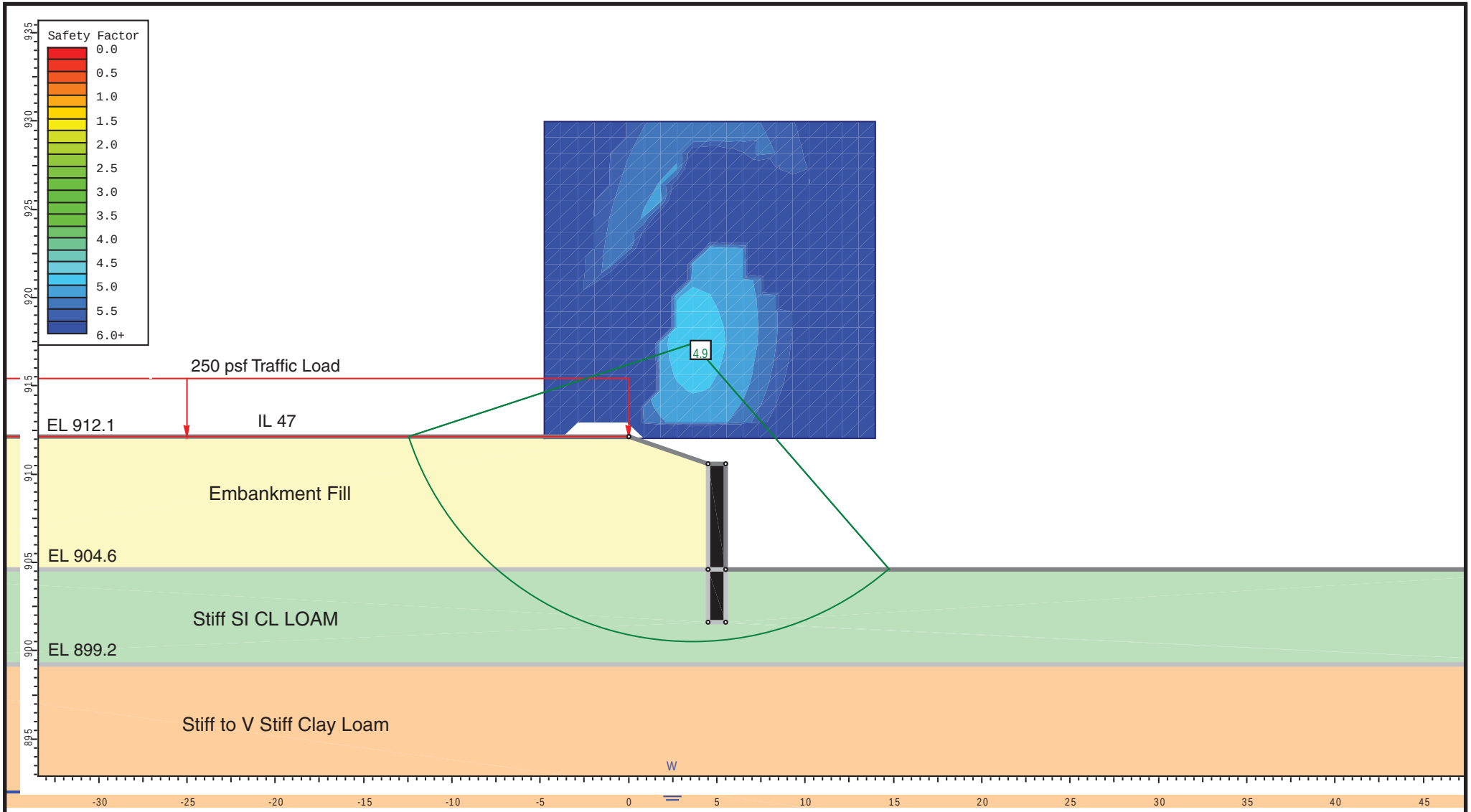
APPENDIX C



Undrained Analysis for Culvert, Reference Boring: CUL-09

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	Embankment FILL	125	1000	0
2	Stiff SI CL LOAM	120	1100	0
3	Stiff to V Stiff Clay Loam	120	2300	0

GLOBAL STABILITY ANALYSIS: IL 47 CULVERT AT STATION 654+07, SN 056-0311, MCHENRY COUNTY

SCALE: GRAPHICAL | APPENDIX C-1 | DRAWN BY: RKC CHECKED BY: A. Kurnia

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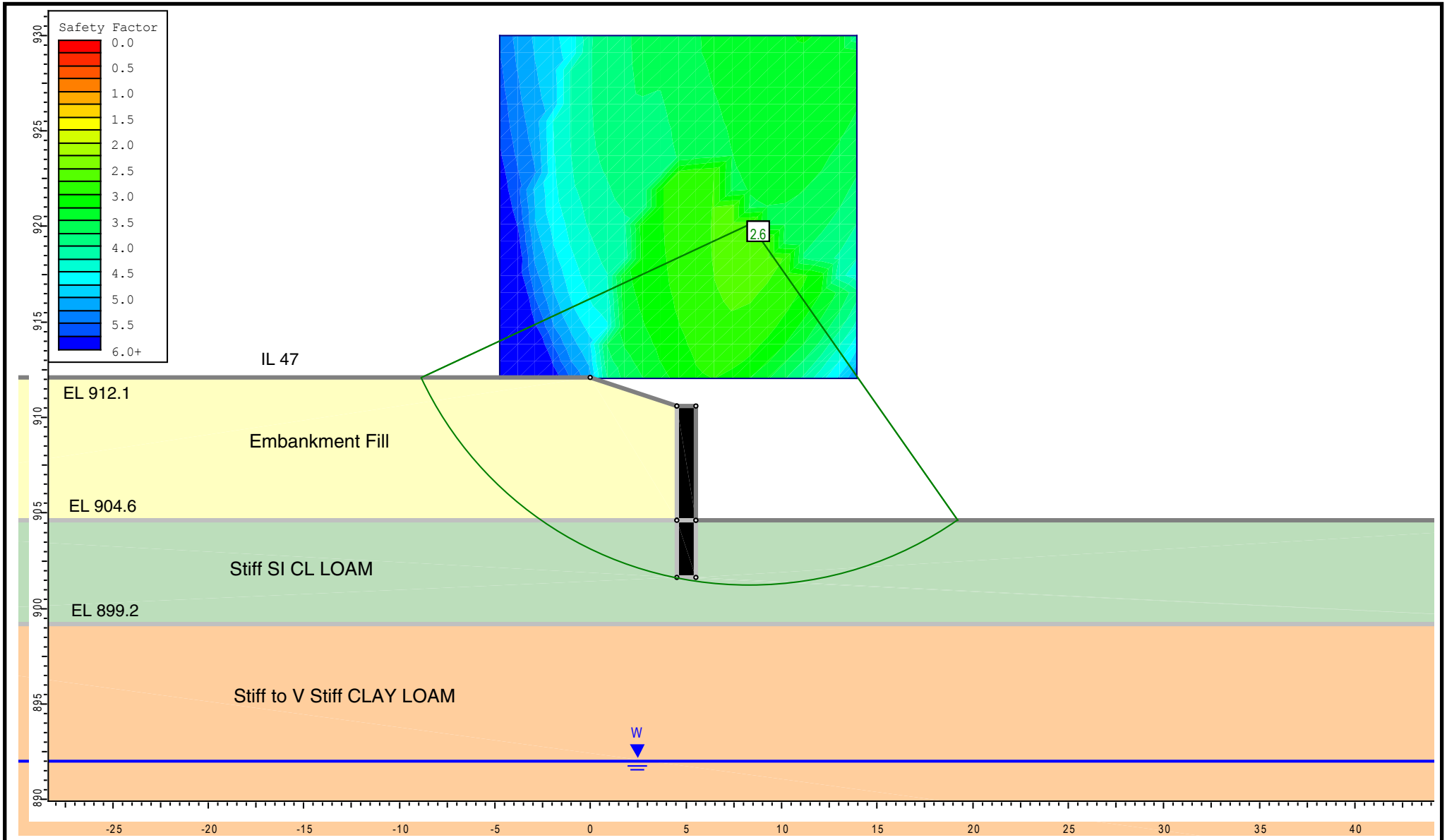

Drained Analysis for Culvert, Reference Boring: CUL-09

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	Embankment FILL	125	100	30
2	Stiff SI CL LOAM	120	100	31
3	Stiff to V Stiff CLAY LOAM	120	0	32

GLOBAL STABILITY ANALYSIS: IL 47 CULVERT AT STATION 654+07, SN 056-0311, MCHENRY COUNTY

SCALE: GRAPHICAL | APPENDIX C-2 | DRAWN BY: RKC CHECKED BY: A. Kurnia

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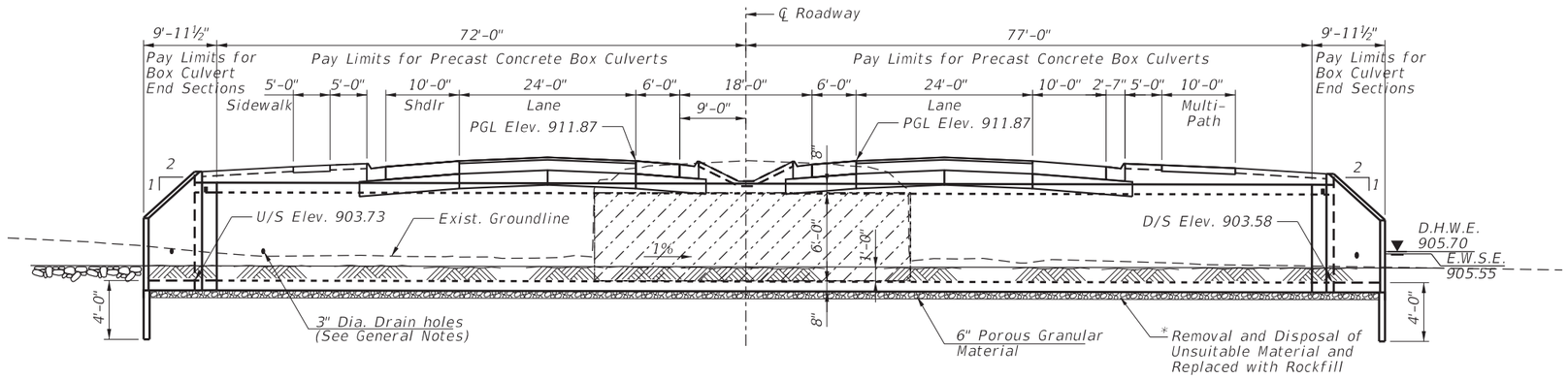
APPENDIX D

Benchmark: BM #12, Set nail in top center of 15" CMP. Elev. 912.37

Existing Structure: SN 056-0245 was built in 1936 as SBI 47 Section 105A. It is a single Box Culvert 6' x 6', 43'-0" Face to Face of Headwalls.

Traffic Control: Traffic to be maintained utilizing Stage Construction.

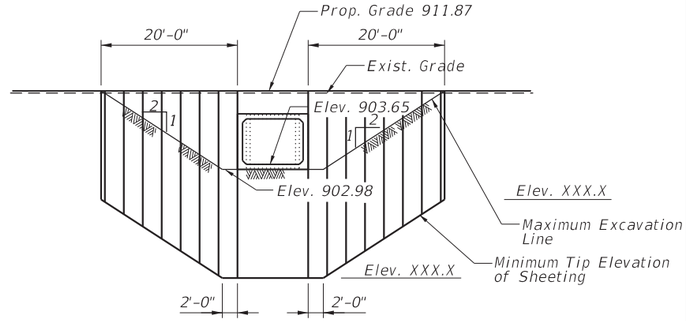
Salvage: None



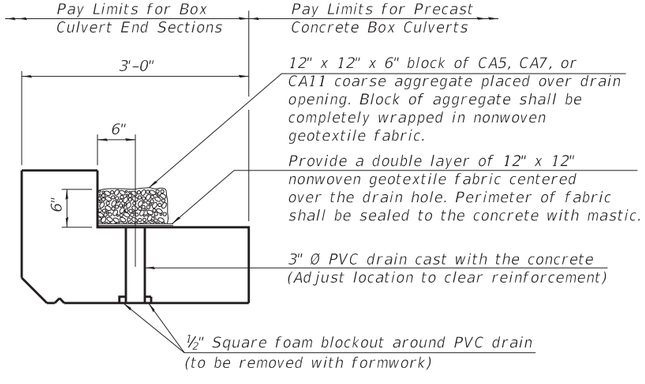
* The limits and quantities of removal and replacement shown are based on the boring data and may be modified by the District Geotechnical and Field Engineers for variable subsurface conditions encountered in the field.

The Rockfill shall be capped with 6 in. of CA7 and satisfy the Standard Specifications unless otherwise indicated in the Special Provisions. The cost of the capping material shall be included in the pay item for Rockfill.

ELEVATION

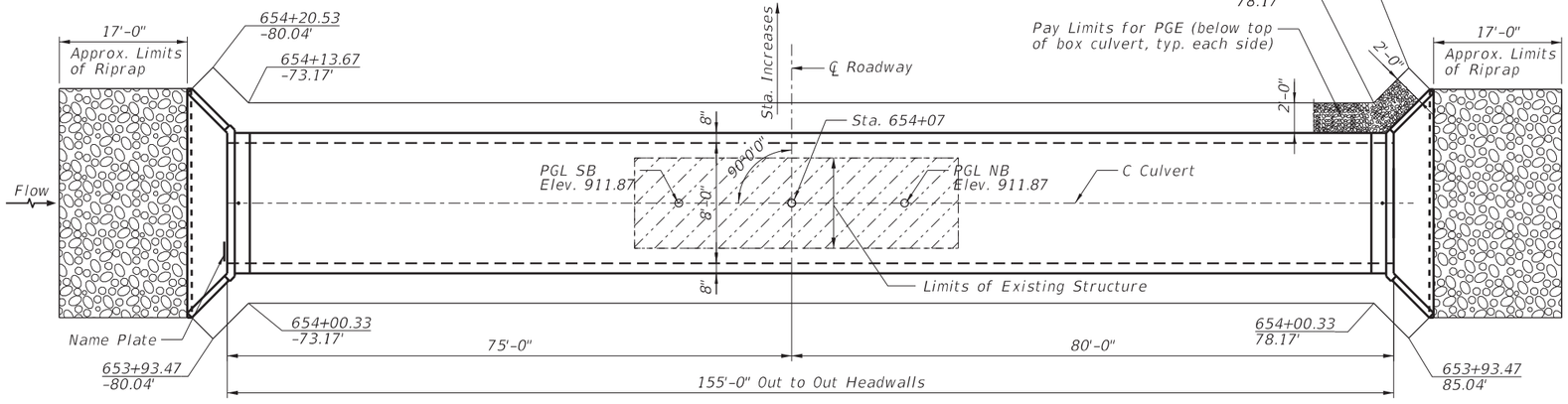


TEMP. SHEET PILING DETAIL



DRAIN DETAIL

(All costs associated with furnishing and constructing the above drain detail will not be measured for payment but shall be included in the contract unit price for the associated work.)

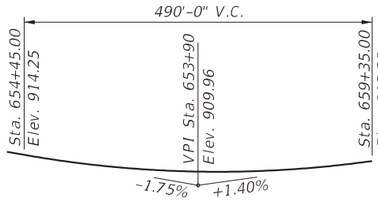


PLAN

WATERWAY INFORMATION

Drainage Area = 0.0603 sq. mi. Low Grade Elev. = 911.88 @ Sta. 654+00

Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	14.10	5.7	6.6	905.55	0.16	0.28	905.71	905.83
Design	50	33.90	6.6	7.8	905.70	0.77	0.84	906.47	906.54
Base	100	50.00	7.1	8.4	905.78	1.18	1.22	906.96	907.00
Overtopping									
Max. Calc.	500	85.00	7.9	9.5	905.92	1.97	1.95	907.89	907.87

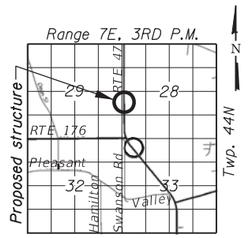


PROFILE GRADE - NB AND SB

STATION 654+07
BUILT BY
STATE OF ILLINOIS
F.A.P. RT. 326 SEC.
LOADING HL-93
STR. NO. 056-0311

NAME PLATE

See Std. 515001



LOCATION SKETCH

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications
8th Edition

LOADING HL-93

50 PSF Future Wearing Surface

DESIGN STRESSES

PRECAST UNITS

f'c = 5,000 psi
fy = 65,000 psi (Welded Wire Reinforcement)

GENERAL PLAN AND ELEVATION
IL RTE. 47 OVER
KISHWAUKEE RIVER TRIBUTARY
F.A.P. RTE. 326 SEC 105-N-2(15)
McHENRY COUNTY
STATION 654+07
S.N. 056-0311

MODEL: Default
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CHRISTOPHER B. BURKE ENGINEERING, LTD.
9575 W. HIGGINS ROAD, SUITE 600
ROSEMONT, ILLINOIS 60018
(847) 823-0500

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN AND ELEVATION
STRUCTURE NO. 056-0311

SCALE: N.T.S. | SHEET 1 OF 7 SHEETS | STA. 654+07 | TO STA. ---

F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	473	365
		CONTRACT NO. 62B43		
	ILLINOIS	FED. AID PROJECT		

GENERAL NOTES

1 The design fill height for this box is 3'-0". The precast box culvert sections shall conform to the requirements of ASTM C 1577.

2. Drain holes shall be provided on exterior culvert walls for each precast box segment with a clear rise greater than 3 ft. The drain hole shall be located within 1/3 of the clear rise of the box culvert, shall not intercept the haunch, and shall conform to the requirements of Article 503.11 of the Standard Specification.

3. The 6 in. thick layer of porous granular material required for the precast concrete box culvert per Art. 540.06 of the Standard Specifications shall also apply to the end sections. Cost of the porous granular material will not be paid for separately but shall be included in the unit price of the work for which it is required.

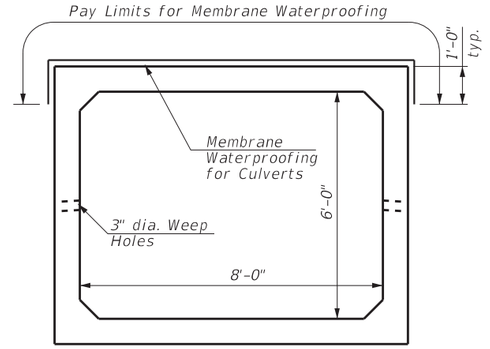
4. Nonwoven geotextile fabric shall conform to the requirements of Art. 1080.01 of the Standard Specifications. The minimum weight of the fabric shall be 6 ounces per square yard.

5. Precast concrete box culverts and box culvert end sections shall be backfilled with Porous Granular Embankment below the top of the box culvert extending to a vertical plane 2 ft from the exterior sides of the culvert, 2 ft from the back face of the end sections, and not closer than 2 ft from the face of embankment.

INDEX OF SHEETS

TOTAL BILL OF MATERIAL

ITEM	UNIT	TOTAL
Porous Granular Embankment	Cu. Yd.	240
Stone Riprap, Class A4	Sq. Yd.	95
Filter Fabric	Sq. Yd.	95
Removal of Existing Structures No. 3	Each	1
Structure Excavation	Cu. Yd.	354
Removal and Disposal of Unsuitable Material for Structures	Cu. Yd.	77
Name Plates	Each	1
Temporary Sheet Piling	Sq. Ft.	1,376
Box Culvert End Sections, Culvert No. 3	Each	2
Precast Concrete Box Culverts 8' X 6'	Foot	149
Membrane Waterproofing for Buried Structures	Sq. Yd.	195
Dewatering	L. Sum	0.25
Rock Fill	Cu. Yd.	77



MEMBER WATERPROOFING FOR PRECAST CULVERTS

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL NOTES, INDEX OF SHEETS AND TOTAL BILL OF MATERIALS
STRUCTURE NO. 056-0311

SCALE: N.T.S. | SHEET 2 OF 7 SHEETS | STA. | TO STA. ----

F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	473	366
		CONTRACT NO. 62B43		
	ILLINOIS	FED. AID PROJECT		

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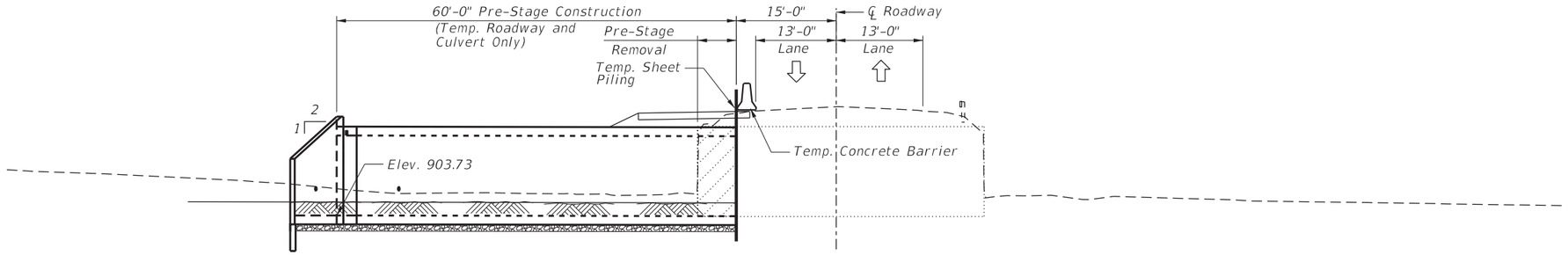
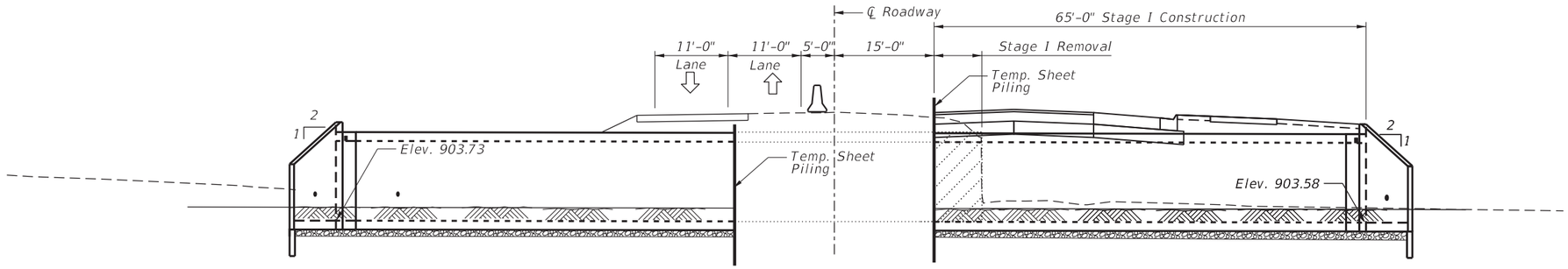
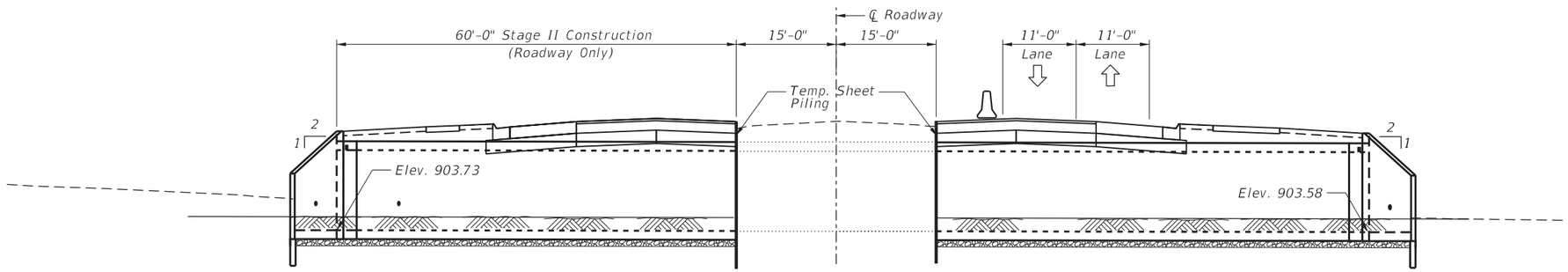


PRE-STAGE



STAGE I



STAGE II

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F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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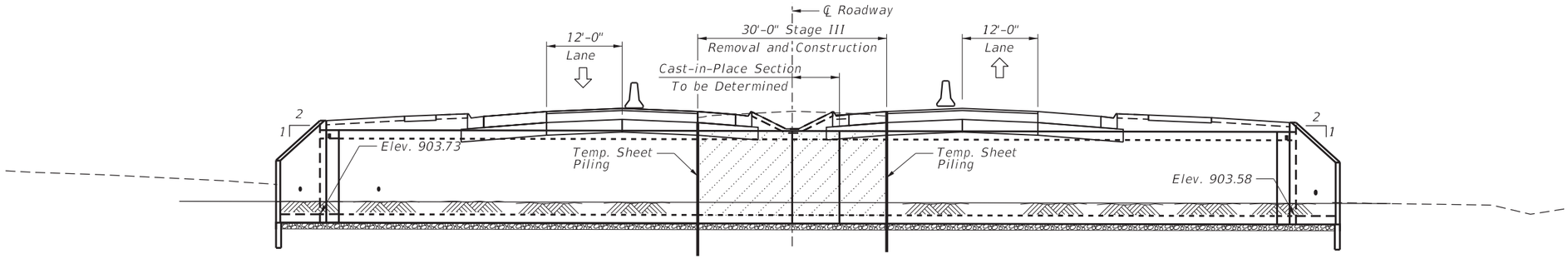
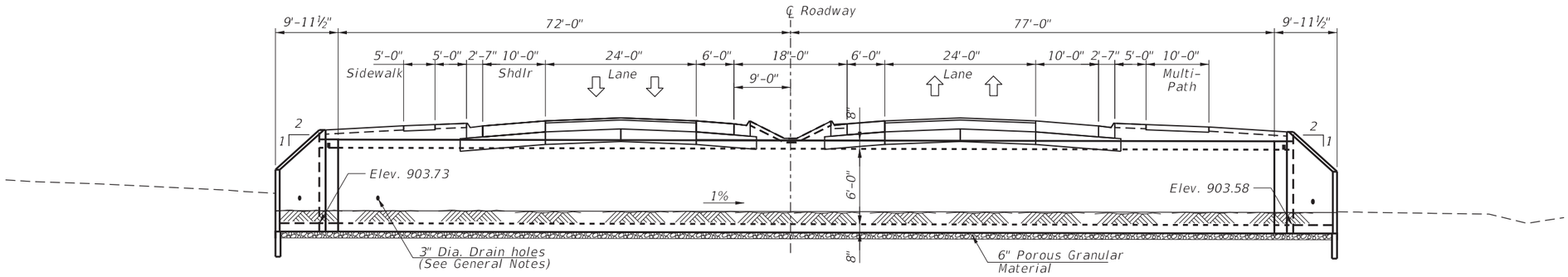
		CONTRACT NO. 62B43		
	ILLINOIS FED. AID PROJECT			



STAGE III



FINAL STAGE

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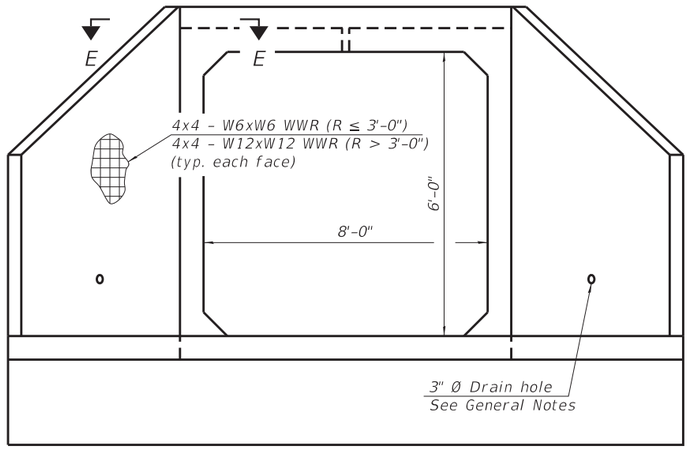
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

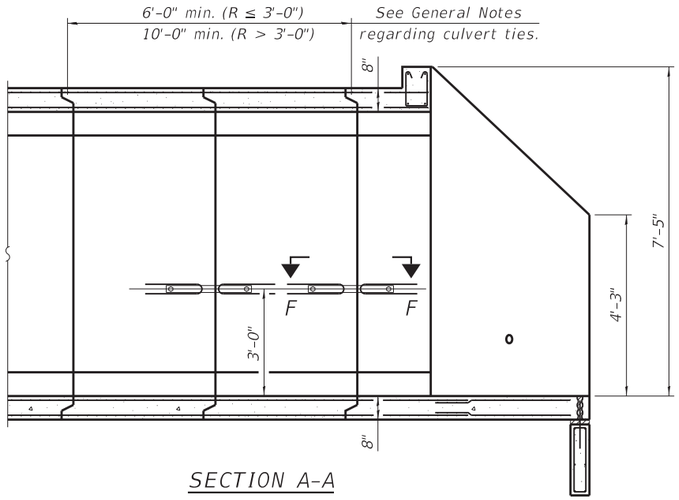
STAGE CONSTRUCTION DETAIL
STRUCTURE NO. 056-0311

SCALE: N.T.S. | SHEET 4 OF 7 SHEETS | STA. 654+07 | TO STA. ---

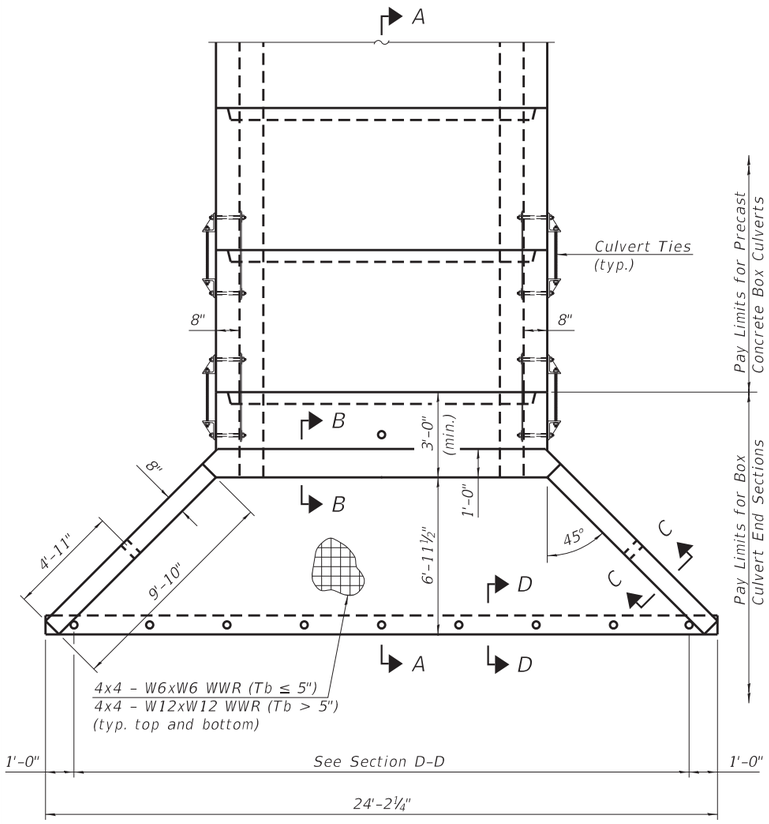
F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	473	368
		CONTRACT NO. 62B43		
	ILLINOIS FED. AID PROJECT			



END VIEW



SECTION A-A



PLAN

GENERAL NOTES

APRON END SECTION DIMENSIONS

Span (S)	Rise (R)	Tt	Tb	Ts	A	B	C	D	E	Concrete Cu. Yd.	Culvert Ties Required
8'-0"	6'-0"	8"	8"	8"	7'-5"	4'-3"	6'-11½"	9'-10"	24'-2¼"	11.0	Yes

Note:
Two sets of apron end section dimensions are shown above for some box culvert sizes due to the top and bottom slabs having different thicknesses per ASTM C 1577 for design fill heights less than 2 ft.

SCB-AES

2-17-2017

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STATE OF ILLINOIS
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PRECAST CONCRETE BOX CULVERT APRON END
SECTION DETAILS – STRUCTURE NO. 056-0311

SCALE: N.T.S. | SHEET 5 OF 7 SHEETS | STA. 654+07 | TO STA. ---

F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	473	369
		CONTRACT NO. 62B43		
	ILLINOIS	FED. AID PROJECT		

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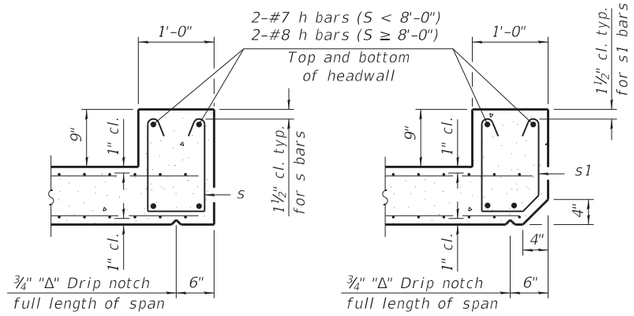
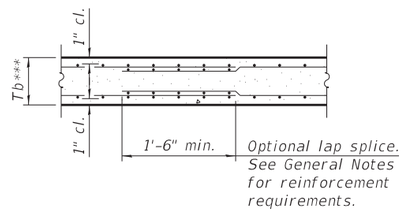


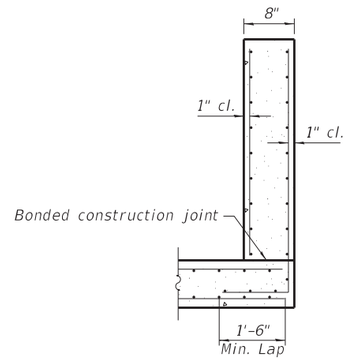
SECTION B-B
(Top slab at downstream end)

SECTION B-B
(Top slab at upstream end)



SECTION B-B
(Bottom Slab)

*** This dimension shall be increased by 2" for CIP construction.



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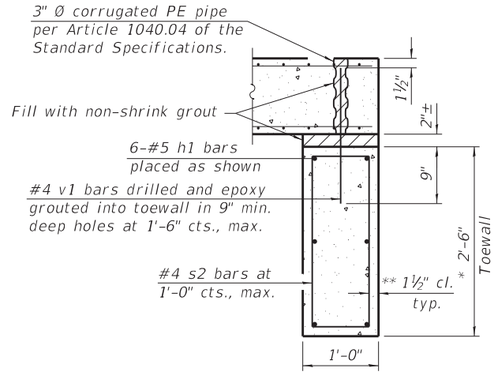

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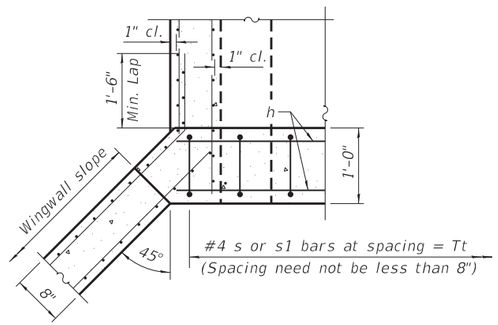

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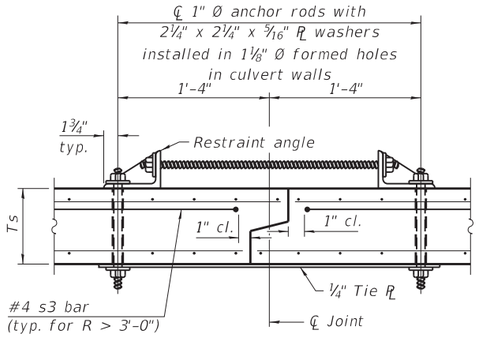


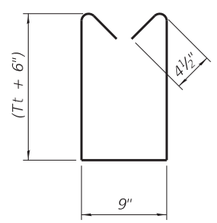
SECTION F-F
(Showing culvert tie details)

TOEWALL CONSTRUCTION SEQUENCE

1. Perform excavation and construct toewall.
2. Backfill accordingly and place bedding for precast box culvert end sections.
3. Set precast box culvert end section.
4. Drill and epoxy grout reinforcement in toewall in accordance with Section 584 of the Standard Specifications.
5. Pressure grout voids using non-shrink grout conforming to Section 1024 of the Standard Specifications.

* The Contractor may furnish a precast or cast-in-place toewall. The Contractor shall be responsible for the strength and stability of the precast toewall during handling. Additional lifting points may be required depending upon the length of the toewall or the Contractor may need to modify the design of the toewall for the proposed handling method.

** If soil conditions permit, the sides of the toewall may be poured directly against the soil. The clear cover on the sides of the toewall shall be increased to 3" by increasing the thickness of the toewall.



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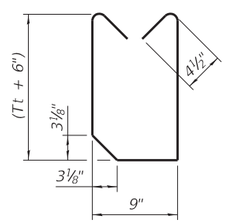

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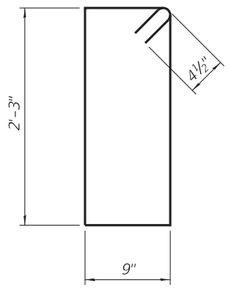

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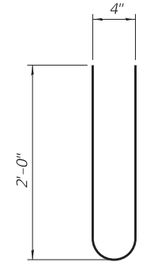

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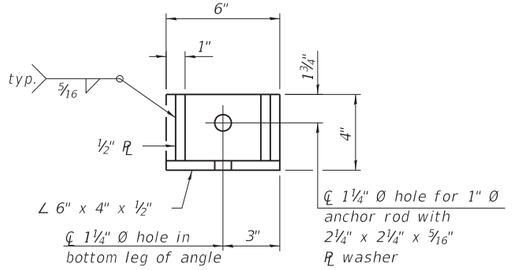
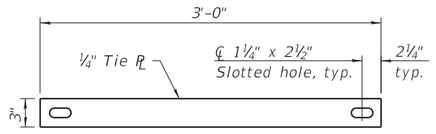


RESTRAINT ANGLE DETAIL



TIE PLATE DETAIL

Notes:

1" Ø anchor rods for the culvert ties shall conform to the requirements of ASTM F1554, Grade 105. Structural steel for the tie plate and restraint angle shall conform to the requirements of Article 1006.04 of the Standard Specifications. All components of the culvert tie detail shall be galvanized according to the requirements of AASHTO M 111 or M 232 as applicable. 2¼"x2¼"x5/16" plate washers shall be provided under each nut required for the anchor rods. Anchor rods connecting precast sections shall be brought to a snug tight condition followed by an additional ½ turn on one of the nuts for anchor rods installed in the walls. Match marks shall be provided on the bolt and nut to verify relative rotation between the bolt and the nut. Holes in the walls for the culvert tie assembly may be drilled using core bits in lieu of using formed holes.

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PRECAST CONCRETE BOX CULVERT APRON END
SECTION DETAILS – STRUCTURE NO. 056-0311

SCALE: N.T.S. | SHEET 6 OF 7 SHEETS | STA. 654+07 | TO STA. ---

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